

CENTRO DE ASTROBIOLOGÍA

Chances of finding preserved biological information in South Meridiani

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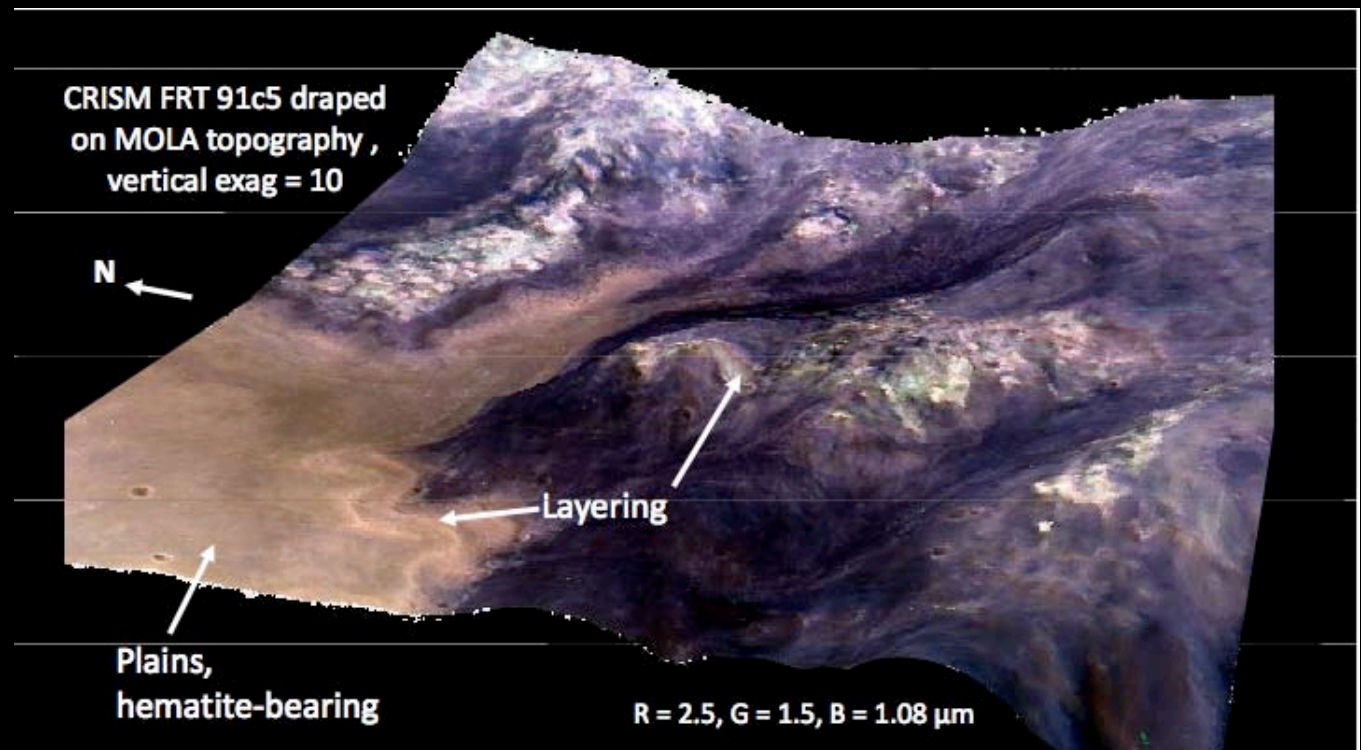
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South Meridiani sedimentary settings

- Succession ranging early and late Noachian to Hesperian:
 - phyllosilicate early materials, acidic sulfates in aeolian-derived deposits and iron oxides
- Records at least one major paleoenvironmental event:
 - (1) mildly acidic to neutral, (2) strong acidic, and (3)? formation of ferric oxides
- Boundary between (1) and (2)
- Main diagenetical pathways should have changed over time
 - Last acidic event may have caused destruction in surface organics but also subsurface through fractures and diaclasses

South Meridiani potential paleobiology

- potentially records the Mars biosphere from very early ages and going through the late Noachian acidic event
- Boundary between phyllo and acidic
 - Shed light in the sulfate and iron deposits
- May record different preservation stages that can not be detected in all cases.

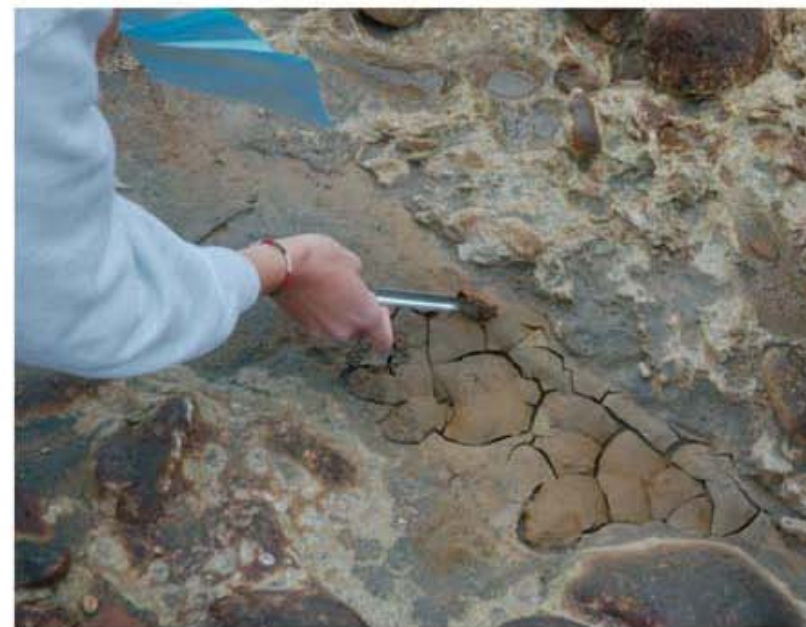
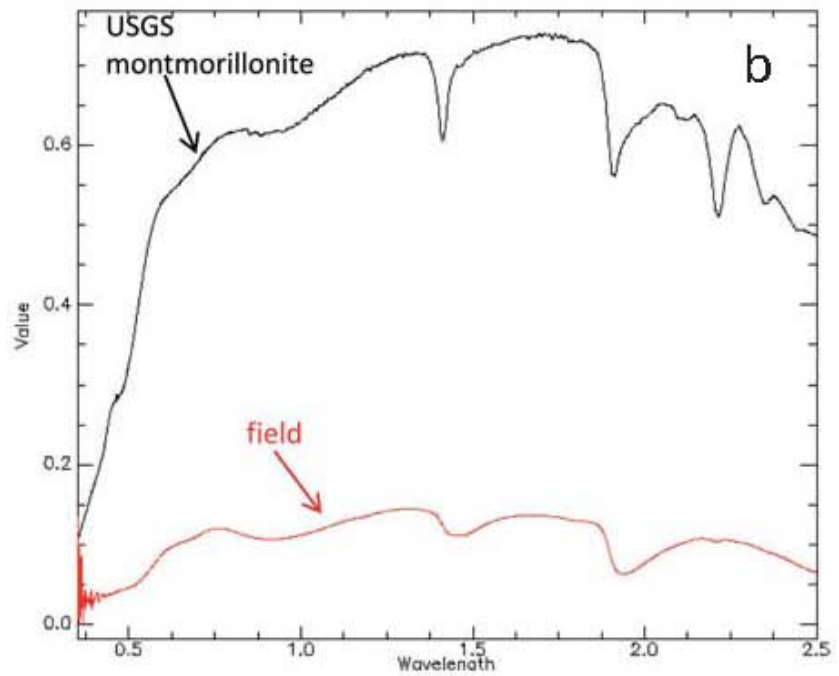
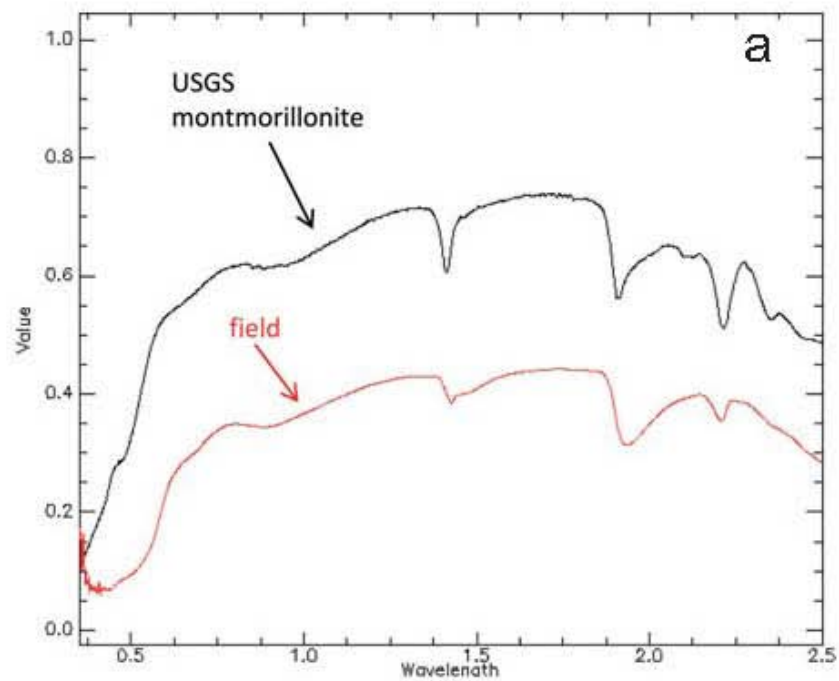


Different materials, different preservation stage of biological information: diagenesis constraints

- Fine-grained with phyllosilicates
 - Organics (and organic-walled microfossils)
- Acidic sulfates
 - organics and microbial structures at different scales
 - Sulfates as biosignatures?
- Iron oxides
 - Structures and highly degraded organics
- Other mineralogies
 - Chlorides and carbonates

Phyllosilicates

- Ideal for preserving organics
- BUT likely affected by the acidic event in any Mars region
 - Phyllosilicates may occur under acidic conditions (pH < 3 montmorillonite, kaolinite, illite, chlorite...)
 - Any early Noachian may have been exposed to acidic leaching even with no sulfate traces around
 - Acidic leaching destroys organics at surface: decreasing concentration or completely removing







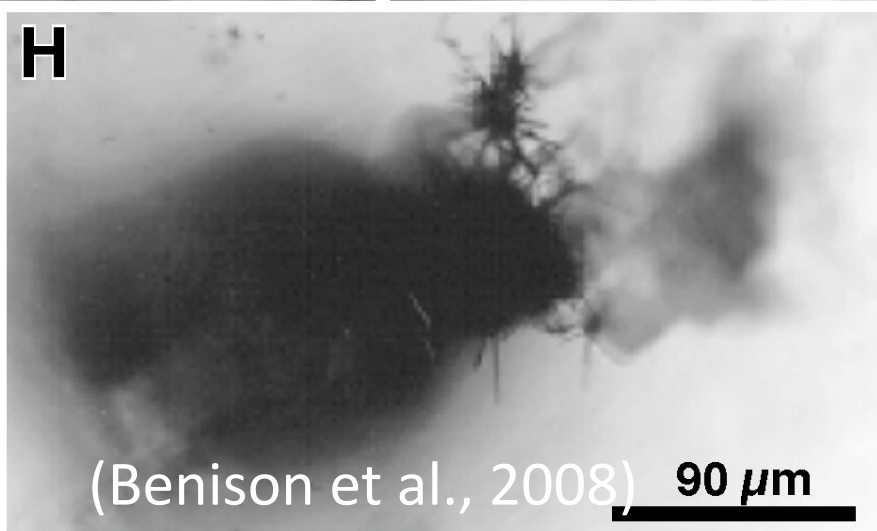
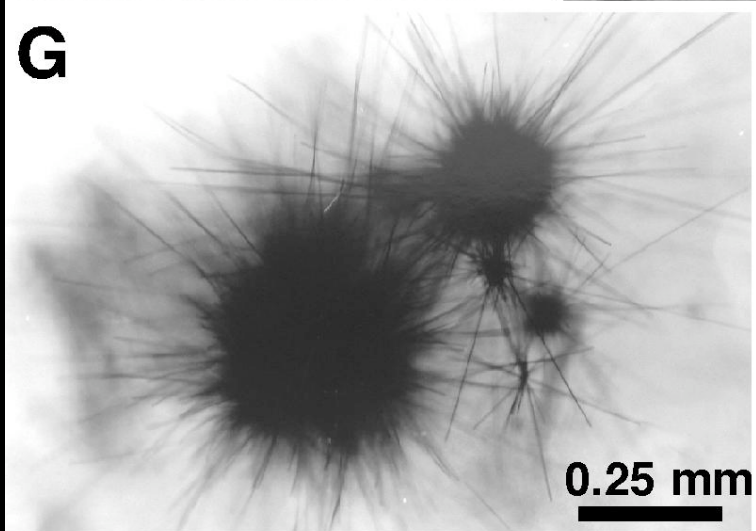
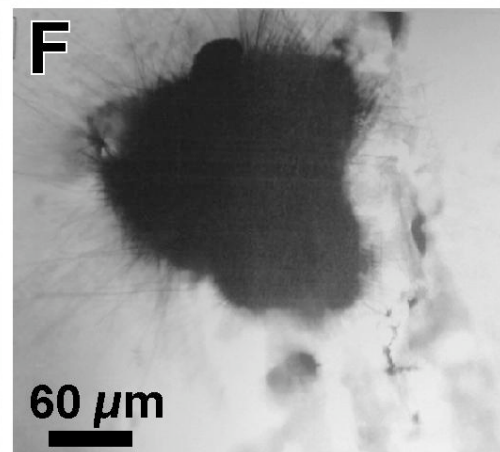
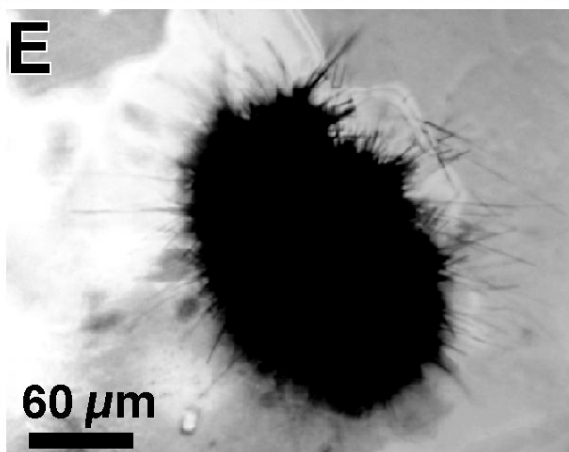
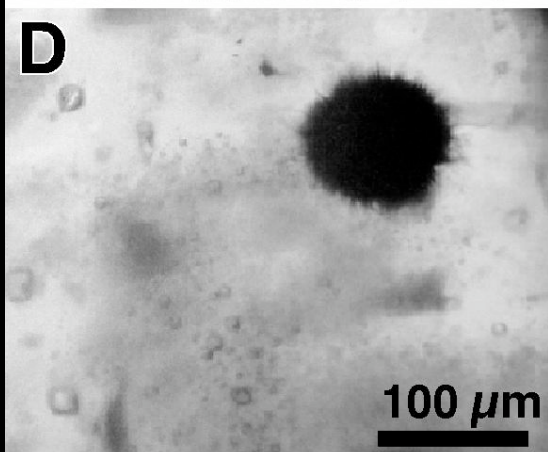
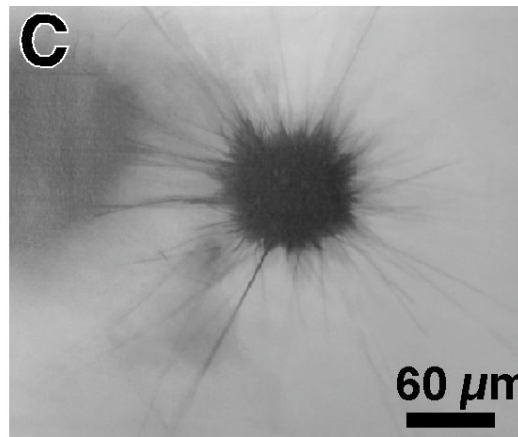
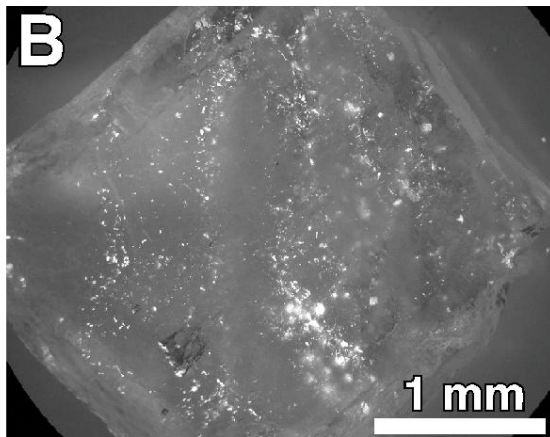
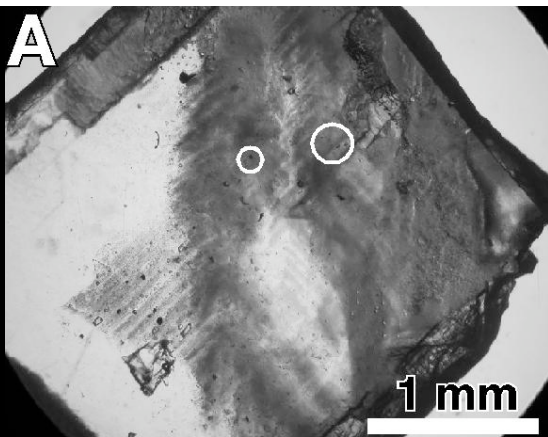
Acidic sulfates

- Maintain structures and organics
 - Gypsum is resistant to late dissolution events
 - Jarosite preserve organics over time (Aubrey et al., 2007)
- Salts can trap dormant microbes (Permian?)
 - Hairy blobs in Permian deposits (Benison et al., 2008)
- Some can form under microbial mediation
 - $\text{Fe}^{3+} + n \cdot \text{CH}_2\text{O} > n \cdot \text{CO}_2 + n \cdot \text{H}_2\text{O} + \text{Fe}^{2+}$
 - $\text{Fe}^{2+} + \text{Ca}^{2+} + \text{SO}_4^{=}$ > Gy + $\text{Fe}^{2+} + \text{SO}_4^{=}$



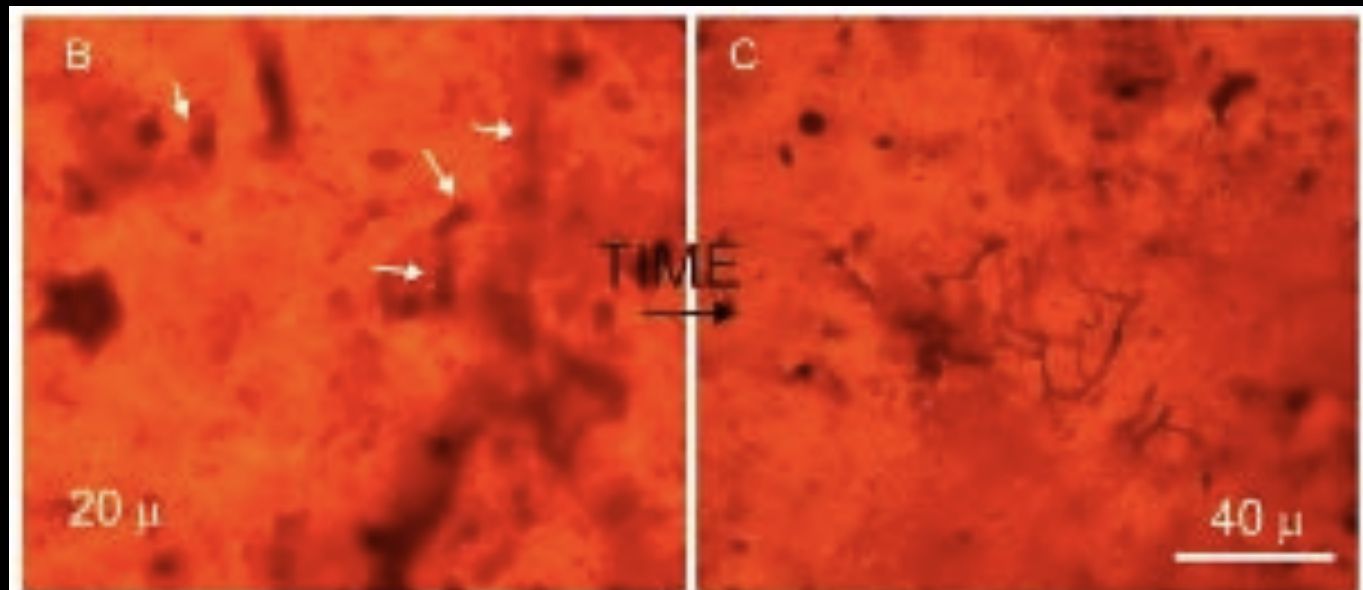


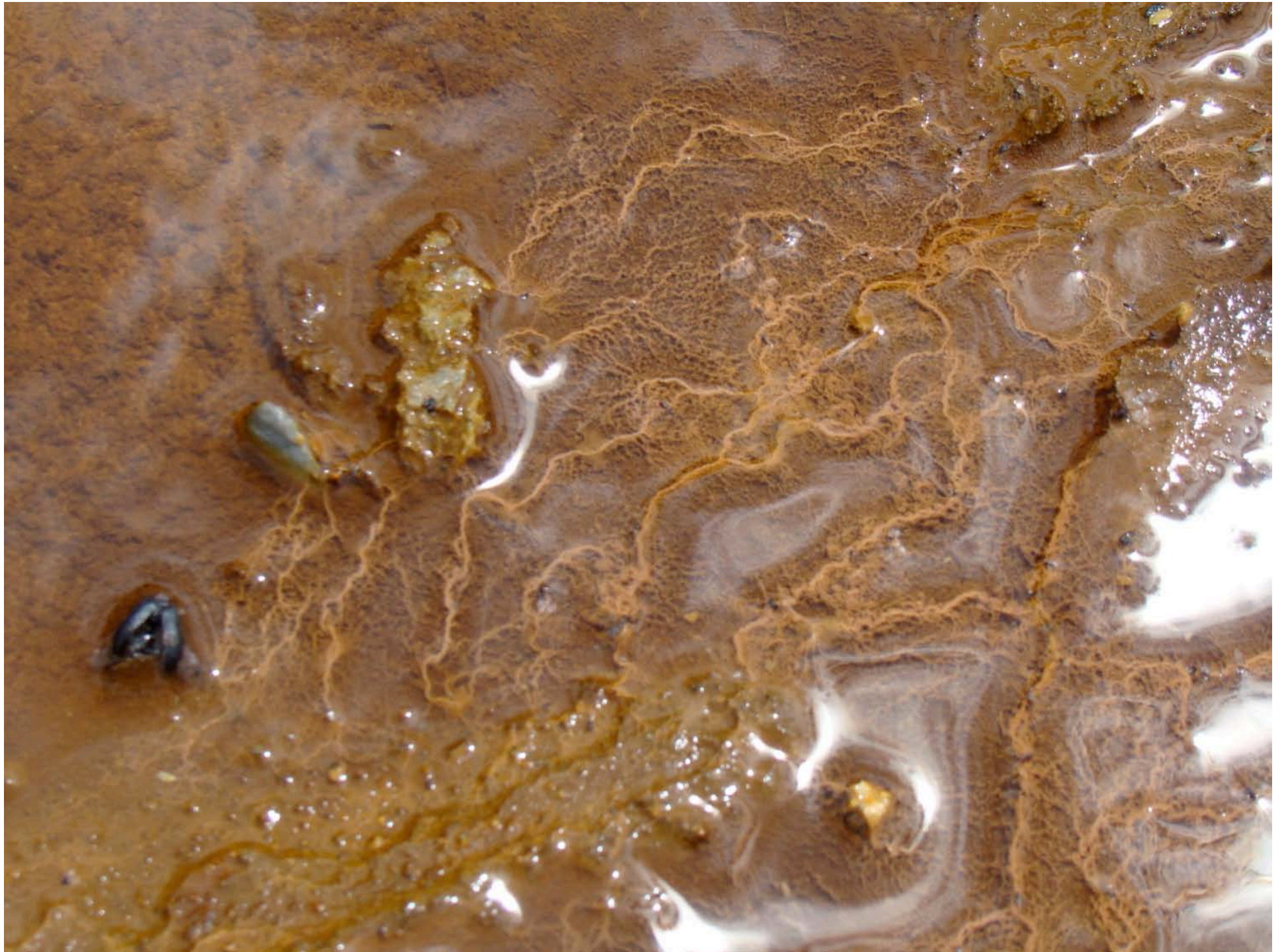




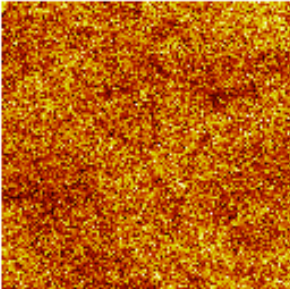
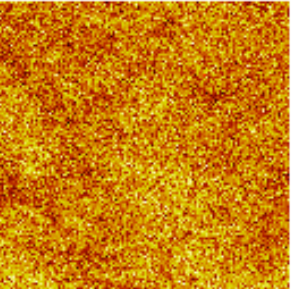
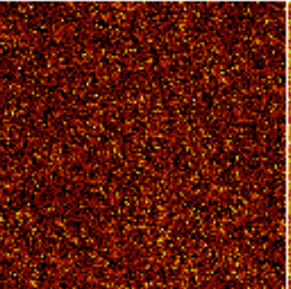
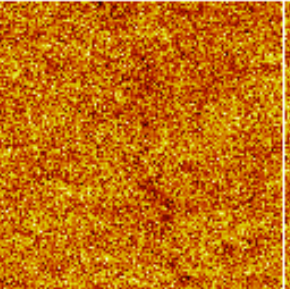
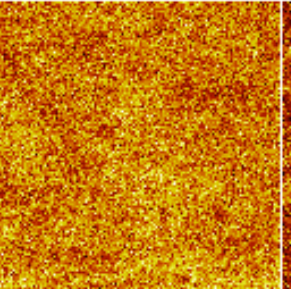
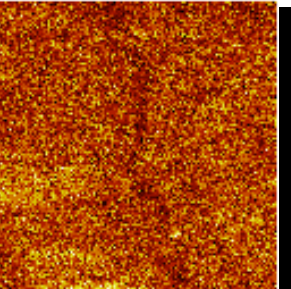
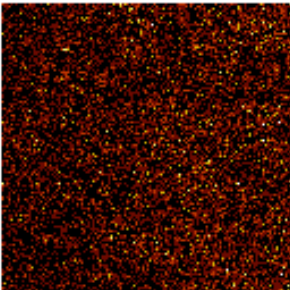
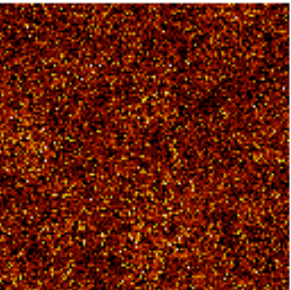
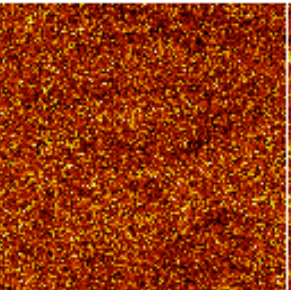
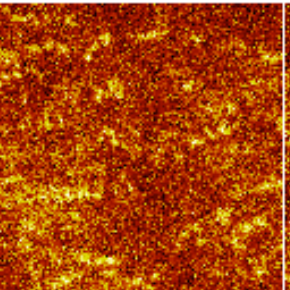
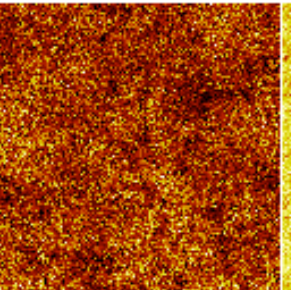
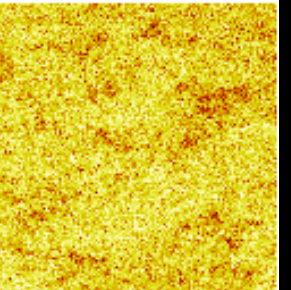
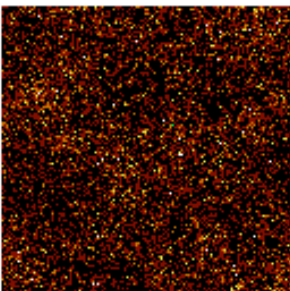
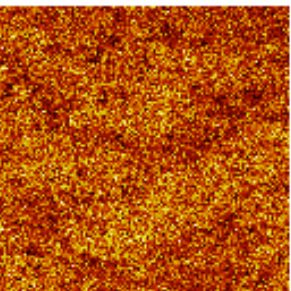
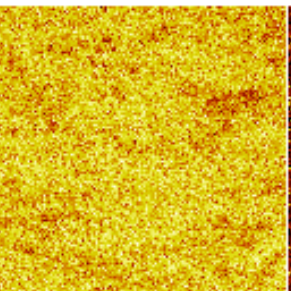
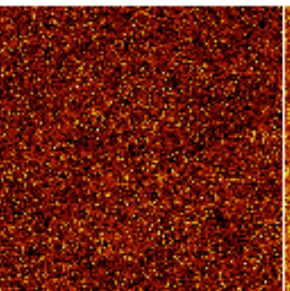
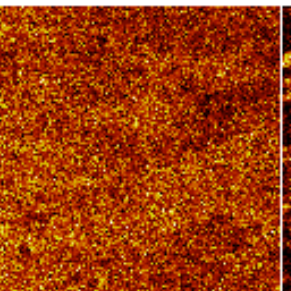
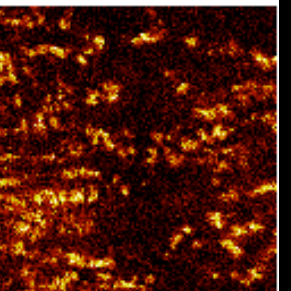
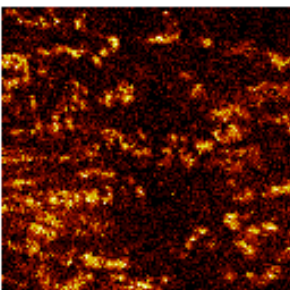
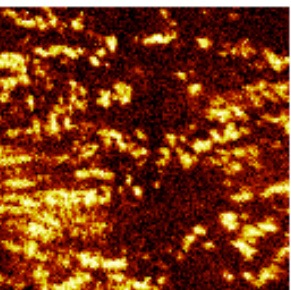
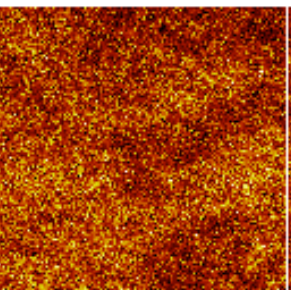
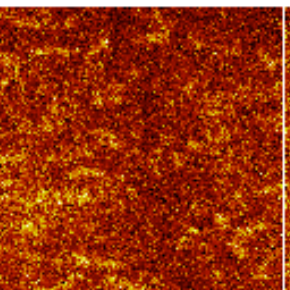
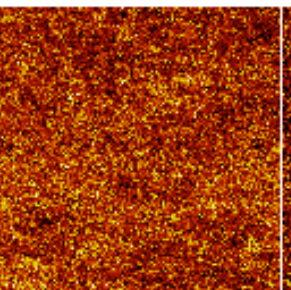
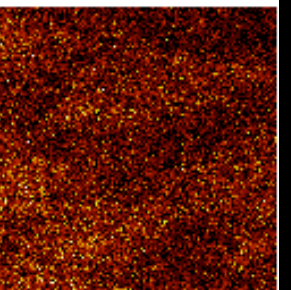
Iron oxides

- Highly resistant to physic and chemical weathering
- Preserve structures well (ferric coating plus trapping inside iron colloids)
- Can preserve organics but
 - Thermodynamically unstable
 - Microbes can madurate/destroy organics (e.g. $\text{Fe}^{3+} > \text{Fe}^{2+}$)





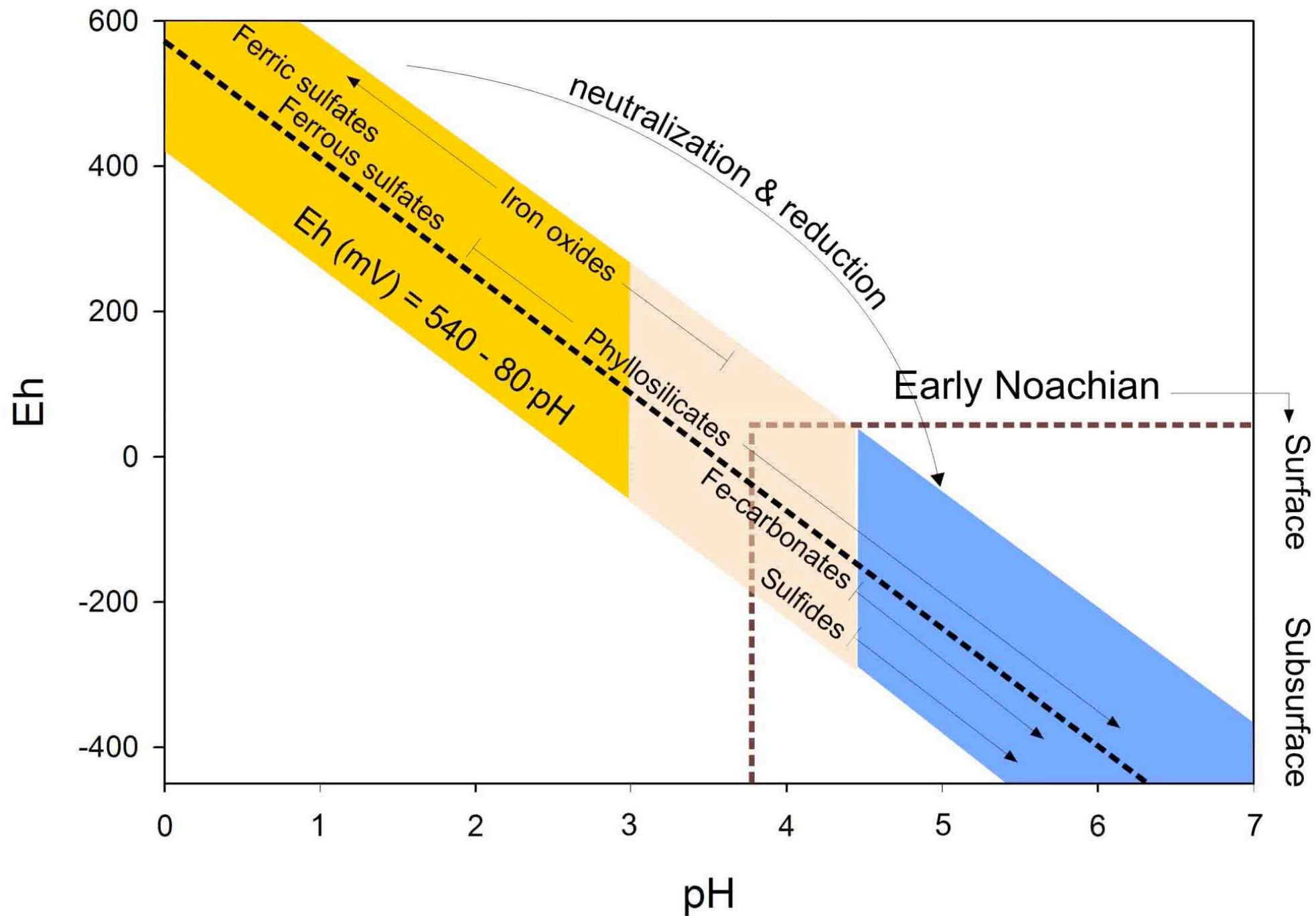


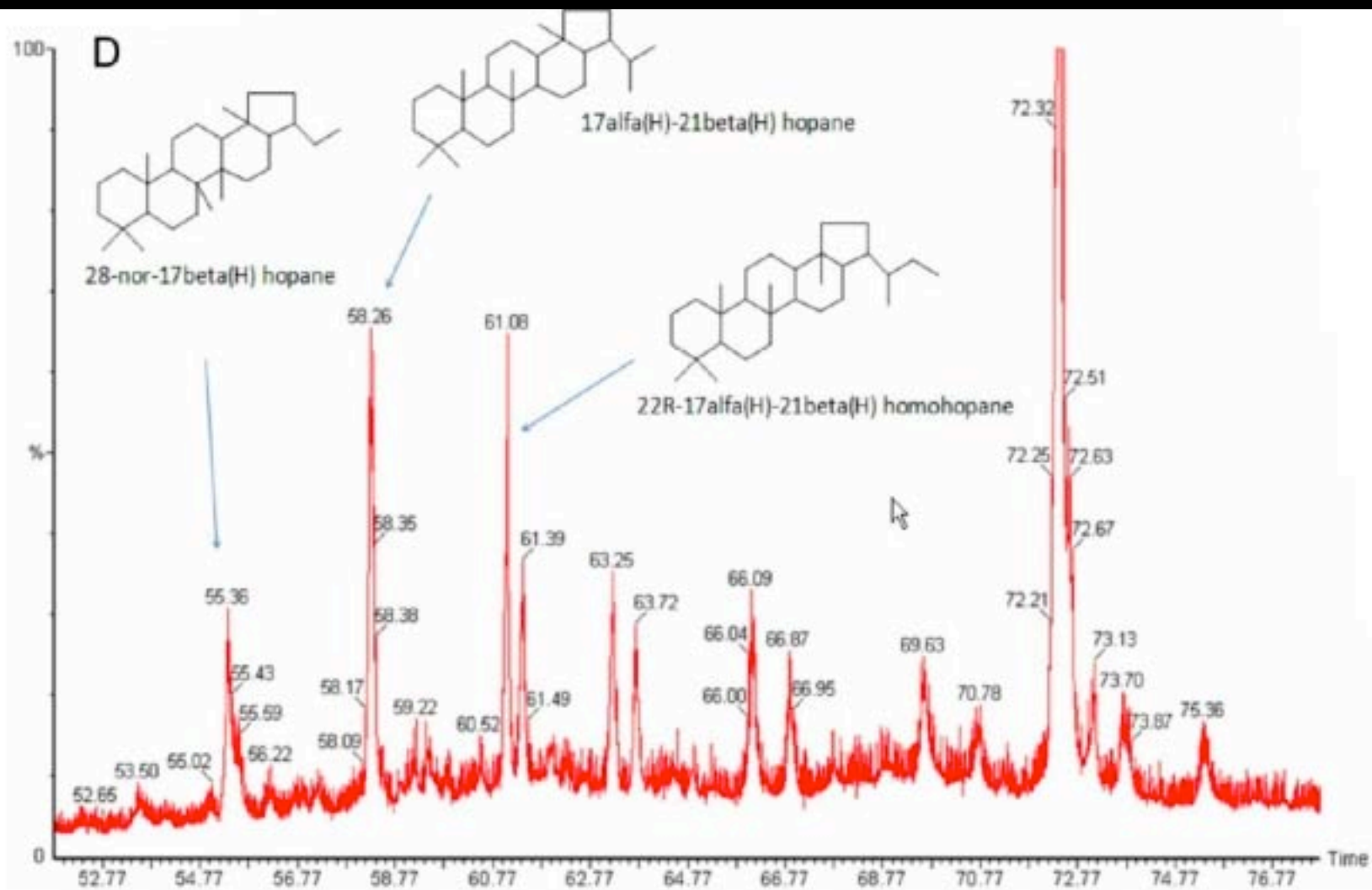
					
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Other mineralogies

- Chlorides and other evaporites
 - Trapping organics and microbes
- Carbonates normally occur as precipitation mediated by microbes
 - Iron oxides deposits originally formed under acidic conditions
 - Subsurface areas of acidic surface conditions (reducing and neutral environments)
 - Associated to organic preservation

Late Noachian





Summary: some parameters for potential preservation and habitability in South Meridiani

	Diagenesis	Structures	Organics	Microbial mediation	Life emergence
Phyllosilicates	2-3 cycles <i>leaching</i>	Micro to middle sized st	leached in surface?	No	Organic polymerization
Iron oxides	1-2 cycles <i>precipitation</i>	Micro to middle sized st	Preserved but overmatured	Coatings	Fe and S protometabolic pathways
Acidic sulfates	1 cycle <i>precipitation</i>	Micro to middle sized st	Preserved	Yes	Fe and S protometabolic pathways
Evaporites	1 cycle <i>precipitation</i>	Micro to middle sized st	Preserved	nucleation	Organic overconcentration
Carbonates	1 cycle <i>precipitation</i>	Micro to middle sized st	Preserved	Yes	Carbon cycling